SCIENCE

VOL. 74 FRIDAY, SEPTEMBER 25, 1931 No. 1917

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS
New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.
Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE SCIENTIFIC WORLD-PICTURE OF TO-DAY[1]

By General the Right Honorable J. C. SMUTS

AFTER what I said at the opening this afternoon it is unnecessary for me to emphasize further the significance of this Centenary Meeting of our association. It is a milestone which enables us to look back upon a hundred years of scientific progress, such as has no parallel in history. It brings us to a point in the advance from which we can confidently look forward to fundamental solutions and discoveries in the near future, which may transform the entire field of science. In this second and greater renaissance of the human spirit this association and its members have borne a foremost part, to which it would be impossible for me to do justice to-night. I shall therefore not attempt to review the achievements of this century of science, but shall content myself with the simpler undertaking of giving a generalized composite impression of the present situation in science. The honor of presiding over this historic meeting, which was not of my seeking, and for which I was chosen on grounds other than my personal merits, is indeed an almost overwhelming one, and I confidently appeal for your indulgence in the difficult task which awaits me to-night.

I am going to ask the question to-night: What sort of world-picture is science leading to? Is science tending towards a definite scientific outlook on the universe, and how does it differ from the traditional outlook of common sense?

The question is not without its interest. For our world-view is closely connected with our sense of ultimate values, our reading of the riddle of the universe, and of the meaning of life and of human destiny. Our scientific world-picture will draw its material from all the sciences. Among these, physical science will—in view of its revolutionary discoveries in recent years—be a most important source. But no less important will be the contribution of the biological sciences with their clear revelation of organic structure and function as well as of organic evolution. And last, not least, the social and mental sciences will not only supply valuable material, but especially methods of interpretation, insights into meanings and values, with-

[1] Address of the president of the British Association for the Advancement of Science, London, September 23, 1931.

out which the perspectives of our world-picture would be hopelessly wrong.

Can we from some reunion or symposium of these sciences obtain a world-picture or synoptic view of the universe, based on observation and calculation, which are the instruments of science, but reaching beyond the particular phenomena which are its immediate field to a conception of the universe as a whole?

That was how science began—in the attempt to find some simple substances or elements to which the complex world of phenomena could in the last analysis be reduced. The century over which we now look back, with its wonderful advance in the methods and technique of exact observation, has been a period of specialization or decentralization. Have we now reached a point where science can again become universal in its ultimate outlook? Has a scientific world-picture become possible?

Of course there can be no final picture at any one stage of culture. The canvas is as large as the universe, and the moving finger of humanity itself will fill it in from age to age. All the advances of knowledge, all the new insights gained from those advances will from time to time be blended into that picture. To the deeper insight of every era of our human advance there has been some such world-picture, however vague and faulty. It has been continually changing with the changing knowledge and beliefs of man. Thus, there was the world of magic and animism, which was followed by that of the early nature gods. There was the geocentric world which still survives in the world of common sense. There is the machine or mechanistic world-view dominant since the time of Galileo and Newton, and now, since the coming of Einstein, being replaced by the mathematician's conception of the universe as a symbolic structure of which no mechanical model is possible. All these world-views have in turn obtained currency according as some well-defined aspect of our advancing knowledge has from time to time been dominant. My object to-night is to focus attention on the sort of world-picture which results from the advances of physical, biological and mental science during the period covered roughly by the activities of our association.

Science arose from our ordinary experience and common-sense outlook. The world of common sense is a world of matter, of material stuff, of real separate things and their properties which act on each other and cause changes in each other. To the various things observable by the senses were added the imperceptible things—space and time, invisible forces, life and the soul. Even these were not enough, and the supernatural was added to the natural world. The original inventory was continually being enlarged, and thus a complex empirical world-view arose, full of latent contradictions, but with a solid basis of actual experience and facts behind it.

Speaking generally, we may say that this is substantially still the common-sense view of the world and the background of our common practical beliefs. How has science dealt with this common-sense empirical world-view? The fundamental procedure of science has been to rely on sense observation and experiment, and to base theory on fact. Thus the vast body of exact science arose, and all entities were discarded which were either inconsistent with observed facts or unnecessary for their strict interpretation. The atomic view of matter was established. Ether was given a status in the physical order, which is now again being questioned in the light of the conception of space-time. New entities like energy emerged; old entities like forces disappeared; the principle of the uniformity of nature was established; the laws of motion, of conservation and of electromagnetism were formulated; and on their basis a closed mechanistic order of nature was constructed, forming a rigid deterministic scheme. Into this scheme it has been difficult, if not impossible, to fit entities like life and mind; and the scientific attitude has on the whole been to put them to a suspense account and to await developments. As to the supernatural, science is or has been agnostic, if not frankly sceptical. Such, in very general terms, was the scientific outlook of the nineteenth century, which has not yet completely passed away. It will be noticed that much of the fundamental outlook of common sense has thus survived, though clarified and purified by a closer accord with facts. This scientific view retained unimpaired and indeed stressed with a new emphasis the things of common sense, matter, time and space, as well as all material or physical entities which are capable of observation or experimental verification. Nineteenth-century science is, in fact, a system of purified, glorified common sense. Its deterministic theory certainly gave a shock to the common man's instinctive belief in free will; in most other respects it conformed to the outlook of common sense. It is true that its practical inventions have produced the most astounding changes in our material civilization, but neither in its methods nor in its world-outlook was there anything really revolutionary.

But underneath this placid surface, the seeds of the future were germinating. With the coming of the twentieth century, fundamental changes began to set in. The new point of departure was reached when physical science ceased to confine its attention to the things that are observed. It dug down to a deeper level, and below the things that appear to the senses, it found, or invented, at the base of the world, so-called scientific entities, not capable of direct observa-

tion, but which are necessary to account for the facts of observation. Thus, below molecules and atoms still more ultimate entities appeared; radiations, electrons and protons emerged as elements which underlie and form our world of matter. Matter itself, the time-honored mother of all, practically disappeared into electrical energy.

> The cloud-capp'd towers, the gorgeous palaces,
> The solemn temples, the great globe itself:

yea, all the material forms of earth and sky and sea were dissolved and spirited away into the blue of energy. Outstanding among the men who brought about this transformation are two of my predecessors in this chair: Sir J. J. Thomson and Lord Rutherford. Like Prospero, like Shakespeare himself, they must be reckoned among the magicians.

Great as was this advance, it does not stand alone. Away in the last century, Clerk Maxwell, following up Faraday's theories and experiments, had formulated his celebrated equations of the electromagnetic field, which applied to light no less than to electromagnetism, and the exploration of this fruitful subject led Minkowski to the amazing discovery in 1908 that time and space were not separate things, but constituent elements in the deeper synthesis of space-time. Thus time is as much of the essence of things as space; it enters from the first into their existence as an integral element. Time is not something extra and superadded to things in their behavior, but is integral and basic to their constitution. The stuff of the world is thus envisaged as events instead of material things.

This physical concept or insight of space-time is our first revolutionary innovation, our first complete break with the old world of common sense. Already it has proved an instrument of amazing power in the newer physics. In the hands of an Einstein it has led beyond Euclid and Newton, to the recasting of the law and the concept of gravitation, and to the new relativity conception of the basic structure of the world. The transformation of the concept of space, owing to the injection into it of time, has destroyed the old passive homogeneous notion of space and has substituted a flexible, variable continuum, the curvatures and unevennesses of which constitute to our senses what we call a material world. The new concept has made it possible to construe matter, mass and energy as but definite measurable conditions of curvature in the structure of space-time. Assuming that electromagnetism will eventually follow the fate of gravitation, we may say that space-time will then appear as the scientific concept for the only physical reality in the universe, and that matter and energy in all their forms will have disappeared as independent entities and will have become mere configurations of this space-time. This will probably involve an amplified concept of space-time. Einstein has recently indicated that for further advance a modification in our space-time concept will become necessary, and that the additional element of direction will have to be incorporated into it. Whatever change may become necessary in our space-time concept, there can be no doubt about the immense possibilities it has opened up.

I pass on to an even more revolutionary recent advance of physics. The space-time world, however novel, however shattering to common sense, is not in conflict with reason. Indeed, the space-time world is largely a discovery of the mathematical reason and is an entirely rational world. It is a world where reason, as it were, dissolves the refractoriness of the old material substance and smooths it out into forms of space-time. Science, which began with empirical brute facts, seems to be heading for the reign of pure reason. But wait a bit; another fundamental discovery of our age has apparently taken us beyond the bounds of rationality, and is thus even more revolutionary than that of space-time. I refer to the quantum theory, Max Planck's discovery at the end of the nineteenth century, according to which energy is granular, consisting of discrete grains or quanta. The world in space-time is a continuum; the quantum action is a negation of continuity. Thus arises the contradiction, not only of common sense, but apparently also of reason itself. The quantum appears to behave like a particle, but a particle out of space or time. As Sir Arthur Eddington graphically puts it, a quantum of light is large enough to fill the lens of a hundred-inch telescope, but it is also small enough to enter an atom. It may spread like a circular wave through the universe, but when it hits its mark, this cosmic wave instantaneously contracts to a point where it strikes with its full and undivided force. Space-time, therefore, does not seem to exist for the quantum, at least not in its lower multiples. Nay, more: the very hitting of its mark presents another strange puzzle, which seems to defy the principles of causation and of the uniformity of nature, and to take us into the realm of chance and probability. The significant thing is that this strange quantum character of the universe is not the result of theory but is an experimental fact well attested from several departments of physics. In spite of the strange Puck-like behavior of the quantum, we should not lightly conclude, with some prominent physicists, that the universe has a skeleton in its cupboard in the shape of an irrational or chaotic factor. Our macroscopic concepts may not fit this ultra-microscopic world of the quantum. And our best hopes for the future are founded on the working out of a new system of concepts and laws suited to this new

world that has swum into the ken of science. The rapid development of wave mechanics in the last four years seems to have brought us within sight of this ideal, and we are beginning to discern a new kind of order in the microscopic elements of the world, very different from any type of law hitherto imagined in science, but none the less a rational order capable of mathematical formulation.

We may summarize these remarks by saying that the vastly improved technique of research has led to physical discoveries in recent years which have at last completely shattered the traditional common-sense view of the material world. A new space-time world has emerged which is essentially immaterial, and in which the old-time matter, and even the scientific mass, gravitation and energy stand for no independent entities, but can best be construed as configurations of space-time. And the discovery of the quantic properties of this world points to still more radical transformations which loom on the horizon of science. The complete recasting of many of our categories of experience and thought may ultimately be involved.

From the brilliant discoveries of physical science we pass on to the advances in biological science which, although far less revolutionary, have been scarcely less important for our world-outlook. The most important biological discovery of the last century was the great fact of organic evolution; and for this fact the space-time concept has at last come to provide the necessary physical basis. It is unnecessary for my purpose to canvass the claims and discuss the views represented by the great names of Lamarck, Darwin and Mendel, beyond saying that they represent a progressive advance in biological discovery, the end of which has by no means been reached yet. Whatever doubts and differences of opinion there may be about the methods, the mechanism or the causes, there is no doubt about the reality of organic evolution, which is one of the most firmly established results in the whole range of science. Paleontology, embryology, comparative anatomy, taxonomy and geographical distribution all combine to give the most convincing testimony that throughout the history of this earth life has advanced genetically from at most a few simple primitive forms to ever more numerous and highly specialized forms. Under the double influence of the internal genetic and the external environmental factors life has subtly adapted itself to the ever-changing situations on this planet. In the process of this evolution not only new structures and organs, but also new functions and powers have successively appeared, culminating in the master key of mind and in the crowning achievement of human personality. To have hammered the great truth of organic evolution into the consciousness of mankind is the undying achievement of Charles Darwin, by the side of which his discovery of natural selection as the method of evolution is of secondary importance.

The acceptance of the theory of evolution has brought about a far-reaching change in our outlook on the universe and our sense of values. The story of creation, so intimately associated with the groundwork of most religions, has thus come to be rewritten. The unity and interconnections of life in all its manifold forms have been clearly recognized. And man himself has had to come down from his privileged position among the angels and take his proper place in the universe as part of the order of nature. Thus Darwin completes the revolution begun by Copernicus.

Space-time finds its natural completion in organic evolution. For in organic evolution the time aspect of the world finds its most authentic expression. The world truly becomes process, where nothing ever remains the same or is a duplicate of anything else, but a growing, gathering, creative stream of unique events rolls forever forward.

But while we recognize this intimate connection between the conceptions of space-time and organic evolution, we should be careful not to identify the time of evolution with that of space-time. There is a very real difference between them. Biological time has direction, passes from the past to the future, and is therefore historical. It corresponds to the "before" and "after" of our conscious experience. Physical time as an aspect of space-time is neutral as regards direction. It is space-like, and may be plus or minus, but does not distinguish between past or future. It may move in either direction, backwards or forwards, while biological time, like the time of experience, knows only a forward flow. Hence cosmic evolution, as we see it in astronomy and physics, is mostly in an opposite direction to that of organic evolution. While biological time on the whole shows a forward movement towards ever higher organization and rising qualities throughout the geological ages, the process of the physical world is mostly in the opposite direction[2]—towards disorganization, disintegration of more complex structures and dissipation of energy. The second law of thermodynamics thus marks the direction of physical time. While the smaller world of life seems on the whole to be on the up-grade, the larger physical universe is on the down-grade. One may say that in the universe we witness a majority movement downward, and a minority movement upward. The energy which is being dissipated by the

[2] No doubt there are exceptions to this broad generalization. In astronomy stars and solar systems and galaxies are probably still being formed, while in physics syntheses of elements may possibly still be going on. In the same way we find in organic evolution minor phases of regression, degeneration and parasitism.

decay of physical structure is being partly taken up and organized into life structures—at any rate on this planet. Life and mind thus appear as products of the cosmic decline, and arise like the phoenix from the ashes of a universe radiating itself away. In them nature seems to have discovered a secret which enables her to irradiate with imperishable glory the decay to which she seems physically doomed.

Another striking point arises here. Organic evolution describes the specific process of what we call life, perhaps the most mysterious phenomenon of this mysterious universe. When we ask what is the nature of life we are curiously reminded of the behavior of the quantum referred to. I do not for a moment wish to say that the quantum is the physical basis of life, but I do say that in the quantum the physical world offers an analogy to life which is at least suggestive. The quantum follows the all-or-nothing law and behaves as an indivisible whole: so does life. A part of a quantum is not something less than a quantum; it is nothing or sheer nonentity: the same holds true of life. The quantum is perhaps most easily symbolized as a wave or combination of waves, which can only exist as a complete periodicity, and whose very concept negatives its existence as partial or truncated. In other words, it is a specific configuration and can only exist as such: the same holds true of life. The quantum does not fall completely within the deterministic causal scheme: the same seems true of life. Significant, also, is the fact that quantum phenomena underlie secondary qualities such as color and the like, which the older science in its mechanistic scheme ignored, but which are specially associated with life and consciousness. Apparently the quantum does not fall completely within the causal deterministic scheme: the same is true of life. Life is not an entity, physical or other. It is a type of organization; it is a specific principle of central or self-organization. If that organization is interfered with we are left, not with bits of life, but with death. The nature of living things is determined, not by the nature of their parts, but by the nature or principle of their organization. In short, the quantum and life seem to have this in common, that they both behave as wholes.

I have before now endeavored to explore the concept of life in the light of the more general concept of the whole. A whole is not a sum of parts, or constituted by its parts. Its nature lies in its constitution more than in its parts. The part in the whole is no longer the same as the part in isolation. The interesting point is that while this concept of the whole applies to life, it is according to the recent physics no less applicable to the ultimate physical units. Thus the electron within an atom is no longer a distinct electron. There may be separate electrons, but when they cease to be separate they also cease to be. The eight electrons which circulate in an oxygen atom are merged in a whole in such a way that they have lost their separate identity; and this loss of individuality has to be taken into account in calculations as to the physical behavior of the atom. The physicist, in fact, finds himself unable to look upon the entity which is one eighth of eight electrons as the same thing as a single electron. At the very foundation, therefore, of physics, the principle or category of the whole applies no less than in the advanced structure of life, although not in the same degree. In the ultimate analysis of the world, both at the physical and the biological level, the part or unit element somehow becomes shadowy and incoherent, and the very basis of mechanism is undermined. It would almost seem as if the world in its very essence is holistic, and as if the notion of individual parts is a practical makeshift without final validity in the nature of things.

The general trend of the recent advances in physics has thus been towards the recognition of the fundamental organic character of the material world. Physics and biology are beginning to look not so utterly unlike each other. Hitherto the great gulf in nature has lain between the material and the vital, between inorganic matter and life. This gulf is now in process of being bridged. The new physics, in dissolving the material world of common sense and discovering the finer structure of physical nature, has at the same time disclosed certain fundamental features which it has in common with the organic world. Stuff-like entities have disappeared and have been replaced by space-time configurations, whose very nature depends on their principle of organization. And this principle, which I have ventured to call holism, appears to be at bottom identical with that which pervades the organic structures of the world of life. The quantum and space-time have brought physics closer to biology. As I have pointed out, the quantum anticipates some of the fundamental characters of life, while space-time forms the physical basis for organic evolution. Physics and biology are thus recognized as respectively simpler and more advanced forms of the same fundamental pattern in world-structure.

The older mechanistic conception of nature, the picture of nature as consisting of fixed material particles, mechanically interacting with each other—already rudely shaken by the relativity theory—is now being modified by the quantum physics. The attack on mechanism, thus coming from physical science itself, is therefore all the more deadly. Even in physics, organization is becoming more important than the somewhat nebulous entities which enter into

matter. Interaction is more and more recognized to be not so much mechanical as organic or holistic, the whole in some respects dominating not only the functioning but the very existence of the entities forming it. The emergence of this organic view of nature from the domain of physics itself is thus a matter of first-rate importance, and must have very far-reaching repercussions for our eventual world-view.

The nature of the organic whole is, however, much more clearly recognized in its proper sphere of biology, and especially in the rapidly advancing science of physiology. Here, too, the correct view has been much obscured by the invasion of mechanistic ideas from the physics of the nineteenth century. A crude materialism all but swamped biology for more than a generation. At the Belfast session of this association in 1874 a famous predecessor of mine in this chair gave unrestained expression to this materialistic creed. All that is passing, if not already past. It must be admitted that up to a point mechanism has been useful as a first approximation and fruitful as a convention for research purposes. But if even in physics it has lost its savor, *a fortiori* has it become out of place in biology. The partial truth of mechanism is always subtended by the deeper truth of organicity or holism. So far from biology being forced into a physical mould, the position will in future be reversed. Physics will look to biology and even to psychology for hints, clues and suggestions. In biology and psychology it will see principles at work in their full maturity which can only be faintly and fitfully recognized in physics. In this way the exchanges of physics, biology and psychology will become fruitful for the science of the future, and lay the basis for a new scientific monism.

A living individual is a physiological whole, in which the parts or organs are but differentiations of this whole for purposes of greater efficiency, and remain in organic continuity throughout. They are parts *of* the individual, and not independent or self-contained units which *compose* the individual. It is only this conception of the individual as a dynamic organic whole which will make intelligible the extraordinary unity which characterizes the multiplicity of functions in an organism, the mobile, ever-changing balance and interdependence of the numerous regulatory processes in it, as well as the operation of all the mechanisms by which organic evolution is brought about. This conception applies not only to individuals, but also to organic societies, such as a beehive or an ants' nest, and even to social organizations on the human level.

As the concept of space-time destroys the purely spatial character of things, so the concept of the organic whole must also be extended beyond the spatial limits of the organism so as to include its interaction with its environment. The stimuli and responses which render them mutually interdependent constitute them one whole which thus transcends purely spatial aspects. It is this overflow of organic wholes beyond their apparent spatial limits which binds all nature together and prevents it from being a mere assemblage of separate interacting units.

It is time, however, that we pass on to the world of mind. From matter, as now transformed by space-time and the quantum, we pass step by step through organic nature to conscious mind. Gone is the time when Descartes could divide the world into only two substances: extended substance or matter, and thinking substance or mind. There is a whole world of gradations between these two limits. On Descartes' false dichotomy the separate provinces of modern science and philosophy were demarcated. But it is as dead as the epicycles of Ptolemy, and ultimately the Cartesian frontiers between physics and philosophy must largely disappear, and philosophy once more become metaphysic in the original sense. In the meantime, under its harmful influence, the paths of matter and mind, of science and philosophy, were made to diverge farther and farther, so that only the revolution now taking place in thought could bring them together again. I believe, however, their reunion is coming fast. We have seen matter and life indefinitely approaching each other in the ultimate constituents of the world. We have seen that matter is fundamentally a configuration or organization of space-time; and we have seen that life is a principle of organization whereby the space-time patterns are arranged into organic unities. The next step is to show that mind is an even more potent embodiment of the organizing whole-making principle, and that this embodiment has found expression in a rising series, which begins practically on the lowest levels of life, and rises ultimately to the conscious mind which alone Descartes had in view in his classification. I have no time to follow up the matter here beyond making a few remarks.

Mind is admittedly an active, conative, organizing principle. It is forever busy constructing new patterns of things, thoughts or principles out of the material of its experience. Mind, even more than life, is a principle of whole-making. It differentiates, discriminates and selects from its vague experience, and fashions and correlates the resulting features into more or less stable, enduring wholes. Beginning as mere blind tropisms, reflexes and conditioned reflexes, mind in organic nature has advanced step by step in its creative march until in man it has become nature's supreme organ of understanding, endeavor and control—not merely a subjective human organ, but

nature's own power of self-illumination and self-mastery—"The eye with which the universe beholds itself and knows itself divine."

The free creativeness of mind is possible because, as we have seen, the world ultimately consists, not of material stuff, but of patterns, of organization, the evolution of which involves no absolute creation of an alien world of material from nothing. The purely structural character of reality thus helps to render possible and intelligible the free creativeness of life and mind, and accounts for the unlimited wealth of fresh patterns which mind freely creates on the basis of the existing physical patterns.

The highest reach of this creative process is seen in the realm of values, which is the product of the human mind. Great as is the physical universe which confronts us as a given fact, no less great is our reading and evaluation of it in the world of values, as seen in language, literature, culture, civilization, society and the state, law, architecture, art, science, morals and religion. Without this revelation of inner meaning and significance the external physical universe would be but an immense empty shell or crumpled surface. The brute fact here receives its meaning, and a new world arises which gives to nature whatever significance it has. As against the physical configurations of nature we see here the ideal patterns or wholes freely created by the human spirit as a home and an environment for itself.

Among the human values thus created science ranks with art and religion. In its selfless pursuit of truth, in its vision of order and beauty, it partakes of the quality of both. More and more it is beginning to make a profound esthetic and religious appeal to thinking people. Indeed, it may fairly be said that science is perhaps the clearest revelation of God to our age. Science is at last coming into its own as one of the supreme goods of the human race.

While religion, art and science are still separate values, they may not always remain such. Indeed, one of the greatest tasks before the human race will be to link up science with ethical values, and thus to remove grave dangers threatening our future. A serious lag has already developed between our rapid scientific advance and our stationary ethical development, a lag which has already found expression in the greatest tragedy of history. Science must itself help to close this dangerous gap in our advance which threatens the disruption of our civilization and the decay of our species. Its final and perhaps most difficult task may be found just here. Science may be destined to become the most effective drive towards ethical values, and in that way to render its most priceless human service. In saying this I am going beyond the scope of science as at present understood, but the conception of science itself is bound to be affected by its eventual integration with the other great values.

I have now finished my rapid and necessarily superficial survey of the more prominent recent tendencies in science, and I proceed to summarize the results and draw my conclusions, in so far as they bear on our world-picture.

In the first place we have seen that in the ultimate physical analysis science reaches a microscopic world of scientific entities, very different in character and behavior from the macroscopic world of matter, space and time. The world of atoms, electrons, protons, radiations and quanta does not seem to be in space-time, or to conform to natural law in the ordinary sense. The behavior of these entities can not be understood without the most abstruse mathematics, nor, apparently, without resort to epistemological considerations. We seem to have passed beyond the definitely physical world into a twilight where physics and metaphysics meet, where space-time does not exist, and where strictly causal law in the old sense does not apply. From this uncertain nebulous underworld there seems to crystallize out, or literally to materialize, the macroscopic world which is the proper sphere of sensuous observation and of natural laws. The pre-material entities or units condense and cohere into constellations, which increase in size and structure until they reach the macroscopic stage of observation. As the macroscopic entities emerge, their space-time field and appropriate natural laws (mostly of a statistical character) emerge *pari passu*. We seem to pass from one level to another in the evolution of the universe, with different units, different behaviors—and calling for different concepts and laws. Similarly, we rise to new levels as later on we pass from the physical to the biological level, and again from the latter to the level of conscious mind. But—and this is the significant fact—all these levels are genetically related and form an evolutionary series; and underlying the differences of the successive levels, there remains a fundamental unity of plan or organization which binds them together as members of a genetic series, as a growing, evolving, creative universe.

In the second place let us see how common sense deals with this macroscopic world. On this stage common sense recognizes three levels of matter, life and mind as together composing the world. But it places them so far apart and makes them so inherently different from each other that relations between them appear unintelligible, if not impossible. The common-sense notions of matter, life and mind make any relations between them, as well as the world which they form, an insoluble puzzle. The older science there-

fore attempted to reduce life substantially to terms of matter, and to put a question mark behind mind; and the result was a predominantly materialistic view of the world. The space-time relativity concept of the world has overcome the difficulty by destroying the old concept of matter, and reducing it from a self-subsistent entity to a configuration of space-time —in other words, to a special organization of the basic world-structure. If matter is essentially immaterial structure or organization, it can not fundamentally be so different from organism or life, which is best envisaged as a principle of organization; nor from mind, which is an active organizer. Matter, life and mind thus translate roughly into organization, organism, organizer. The all-or-none law of the quantum, which also applies to life and mind, is another indication that matter, life and mind may be but different stages or levels of the same activity in the world which I have associated with the pervading feature of whole-making. Materialism has thus gone by the board, and the unintelligible trinity of common sense (matter, life, mind) has been reinterpreted and transformed and put on the way to a new monism.

In the third place, the iron determination of the older science, so contrary to direct human experience, so destructive of the free activity of life and mind, as well as subversive of the moral responsibility of the individual, has also been materially recast. It was due to the Newtonian causal scheme which, as I have indicated, has been profoundly shaken by recent developments. Relativity reduces substance to configuration or patterns, while quantum physics gives definite indications of indeterminism in nature. In any case, life through the ages shows clearly a creative advance to ever more complex organization, and ever higher qualities, while mind is responsible for the creation of a whole realm of values. We are thus justified in stressing, along with natural necessity, an increasing measure of freedom and creativeness in the world, sufficient at least to account for organic evolution and for the appearance of moral law and endeavor. This liberation of life and spirit from the iron rule of necessity is one of the greatest gains from the recent scientific advances. Nature is not a closed physical circle, but has left the door open to the emergence of life and mind and the development of human personality. It has, in its open flexible physical patterns, laid the foundation and established the environment for the coming of life and mind. The view, to which Huxley once gave such eloquent and poignant expression, of a dualism implanted in the heart of nature, of a deadly struggle between cosmic law and moral law, is no longer justified by the subsequent advances of science.

But, in the fourth place, another dualism of a wider reach has appeared, which makes the universe itself appear to be a house divided against itself. For while the stream of physical tendency throughout the universe is on the whole downward, toward disintegration and dissipation, the organic movement, on this planet at least, is upward, and life structures are on the whole becoming more complex throughout the course of organic evolution. From the viewpoint of physics, life and mind are thus singular and exceptional phenomena, not in line with the movement of the universe as a whole. Recent astronomical theory has come to strengthen this view of life as an exceptional feature off the main track of the universe. For the origin of our planetary system is attributed to an unusual accident, and planets such as ours with a favorable environment for life are taken to be rare in the universe. Perhaps we may even say that at the present epoch there is no other globe where life is at the level manifested on the earth. Our origin is thus accidental, our position is exceptional, and our fate is sealed, with the inevitable running down of the solar system. Life and mind, instead of being the natural flowering of the universe, are thus reduced to a very casual and inferior status in the cosmic order. A new meaning and a far deeper poignancy are given to Shakespeare's immortal lines:

> We are such stuff
> As dreams are made of; and our little life
> Is rounded with a sleep.

According to astronomy, life is indeed a lonely and pathetic thing in this physical universe—a transient and embarrassed phantom in an alien, if not hostile, universe.

Such are some of the depressing speculations of recent astronomical theory. But in some respects they have already been discounted in the foregoing. For even if life be merely a terrestrial phenomenon, it is by no means in an alien environment if, as we have seen reason to think, this is an essentially organic universe. In its organic aspects the universe is on the way to life and mind, even if the goal has been actually reached at only one insignificant point in the universe. The potencies of the universe are fundamentally of the same order as its actualities. The universe might say in the words of Rabbi Ben Ezra:

> All I could never be
> All man ignored in me,
> This I was worth to God.

Then again, the very possibility of perception, of knowledge and science depends on an intimate relation between mind and the physical universe. Only thus can the concepts of mind come to be a measure for the facts of the universe, and the laws of nature come

to be revealed and interpreted by nature's own organ of the human mind. Besides science we have other forms of this inner relation between the mind and the universe, such as poetry, music, art and religion. The human spirit is not a pathetic wandering phantom of the universe, but is at home, and meets with spiritual hospitality and response everywhere. Our deepest thoughts and emotions and endeavors are but responses to stimuli which come to us, not from an alien, but from an essentially friendly and kindred universe. So far from the cosmic status of life and mind being degraded by the newer astronomy and physics, I would suggest an alternative interpretation of the facts, more in accord with the trend of evolutionary science. We have seen a macroscopic universe born or revealed to consciousness out of a prior microscopic order of a very different character. Are we not, in the emergence of life and mind, witnessing the birth or revelation of a new world out of the macroscopic physical universe? I suggest that at the present cosmic epoch we are the spectators of what is perhaps the grandest event in the immeasurable history of our universe, and that we must interpret the present phase of the universe as a mother and child universe, still joined together by a placenta which science, in its divorce from the other great values, has hitherto failed to unravel.

Piecing together these clues and conclusions we arrive at a world-picture fuller of mystery than ever. In a way it is closer to common sense and kinder to human nature than was the science of the nineteenth century. Materialism has practically disappeared, and the despotic rule of necessity has been greatly relaxed. In ever varying degree the universe is organic and holistic through and through. Not only organic concepts, but also, and even more so, psychological viewpoints are becoming necessary to elucidate the facts of science. And while the purely human concepts, such as emotion and value, purpose and will, do not apply in the natural sciences, they retain their unimpaired force in the human sciences. The ancient spiritual goods and heirlooms of our race need not be ruthlessly scrapped. The great values and ideals retain their unfading glory and derive new interest and force from a cosmic setting. But in other respects it is a strange new universe, impalpable, immaterial, consisting not of material or stuff, but of organization, of patterns or wholes which are unceasingly being woven to more complex or to simpler designs. In the large it appears to be a decaying, simplifying universe which attained to its perfection of organization in the far-distant past and is now regressing to simpler forms—perhaps for good, perhaps only to restart another cycle of organization. But inside this cosmic process of decline we notice a smaller but far more significant movement—a streaming, protoplasmic tendency; an embryonic infant world emerging, throbbing with passionate life, and striving towards rational and spiritual self-realization. We see the mysterious creative rise of the higher out of the lower, the more from the less, the picture within its framework, the spiritual kernel inside the phenomenal integuments of the universe. Instead of the animistic, or the mechanistic, or the mathematical universe, we see the genetic, organic, holistic universe, in which the decline of the earlier physical patterns provides the opportunity for the emergence of the more advanced vital and rational patterns.

In this holistic universe man is in very truth the offspring of the stars. The world consists not only of electrons and radiations, but also of souls and aspirations. Beauty and holiness are as much aspects of nature as energy and entropy. Thus "in eternal lines to time it grows." An adequate world-view would find them all in their proper context in the framework of the whole. And evolution is perhaps the only way of approach to the framing of a consistent world-picture which would do justice to the immensity, the profundity and the unutterable mystery of the universe.

Such in vague outline is the world-picture to which science seems to me to be pointing. We may not all agree with my rendering of it, which indeed does not claim to be more than a mere sketch. And even if it were generally accepted, we have still to bear in mind that the world-picture of to-morrow will in all probability be very different from any which could be sketched to-day.

SCIENTIFIC EVENTS

THE NATIONAL METAL CONGRESS

The Review, official journal of the American Society for Steel Treating, reports the meeting of the National Metal Congress at Boston, from September 21 to 25. The Institute of Metals and the Iron and Steel Divisions of the American Institute of Mining and Metallurgical Engineers met jointly at the Hotel Statler.

The officers of the Institute of Metals Division were: Sam Tour, *chairman;* Zay Jeffries, *past chairman;* J. R. Freeman, Jr., and C. H. Mathewson, *vice-chairmen,* and William M. Corse, *secretary-treasurer.* John L. Christie and E. M. Wise, respectively chairman and vice-chairman of the papers and publications committee of the division, were active in organizing the technical program for the meeting. The

officers of the Iron and Steel Division were: F. M. Becket, *chairman;* W. J. MacKenzie, *past chairman;* C. B. Murray, W. E. Ruder and F. N. Speller, *vice-chairmen,* and A. B. Kinzel, *secretary.* The program committee of this division consisted of C. E. Meissner, *chairman,* Walter Crafts, G. B. Waterhouse and Clyde E. Williams.

Members of the American Institute of Mining and Metallurgical Engineers registered outside the Georgian Room of the Hotel Statler on Monday morning. Starting on Tuesday morning there were six technical sessions, for which there were 23 important papers. On Thursday afternoon Dr. P. W. Bridgman, Hollis professor of mathematics and natural philosophy at Harvard University, presented the science lecture. His subject was "Recently Discovered Complexities in the Properties of Simple Substances." On Friday afternoon R. J. Cowan presented a paper on "The Development of Continuous Gas Carburizing," at a joint session of the American Society for Steel Treating and the Iron and Steel Division, at which the principal topic was nitriding and carburizing.

The Society of Automotive Engineers cooperated with other engineering societies by having a technical session at the National Metal Congress in connection with an exhibition. Technical sessions were held in the Georgian Room of the Hotel Statler on Wednesday morning, September 23. F. P. Gilligan, chairman of the Iron and Steel Division of the standards committee, presided. He had been active for many years in the society's work and is a past president of the American Society for Steel Treating.

The program of the session comprised three timely papers on important subjects, two of which dealt with the methods and costs of heat treating and made available valuable information bearing more on the economics of the subject than on its purely metallurgical phases. One of these two papers was presented by E. F. Davis, the metallurgist of the Warner Gear Company, and the other by Dr. Haakon Styri, of SKF Industries, Inc. The third paper at the sessions. which was read by F. W. Shipley, foundry metallurgist of the Caterpillar Tractor Company, was devoted to the metallurgical characteristics and advantages of alloyed cast irons, particularly for use in cylinder castings. The number of papers given at this session was limited by the society so that each might be presented in full and ample time allowed for general discussion.

The American Welding Society offered a technical program for their sessions at the congress. All their sessions were held at the Copley Plaza Hotel.

CLINICAL CONGRESS OF THE CONNECTICUT STATE MEDICAL SOCIETY

THREE hundred physicians were expected to attend the seventh annual Clinical Congress of the Connecticut State Medical Society, which was held at New Haven from September 22 to 24. Dr. Creighton Barker was chairman of the committee on enrolment. Equal emphasis and time were given this year to demonstrations and lectures, according to Dr. Barker. In general, morning meetings were devoted to presentation of papers and afternoon meetings to demonstrations of the subjects treated in the papers. All morning and afternoon sessions were concentered at the Yale School of Medicine for the first time in the history of the congress, and this proved to be a time-saver and convenience to those in attendance.

Of unusual interest was an address on infantile paralysis by Dr. William H. Park, of the New York City Department of Health. This paper, in which Dr. Park discussed findings in regard to the prevalence and spread of this disease and measures to be employed in controlling it, was given on Wednesday, at which time diphtheria control also was discussed by Dr. Park and by others, including Dr. Stanley H. Osborn, state commissioner of health of Connecticut, Dr. John L. Rice, health officer of New Haven, and Dr. William F. Wild, health officer of Bridgeport.

General interest centered on an address to be given by Dr. Linsly R. Williams, director of the New York Academy of Medicine, on the subject, "Is Medical Service a Necessity?" This address was given at a dinner meeting held on Tuesday evening at the New Haven Lawn Club, with Dr. Charles C. Gildersleeve, of Norwich, president of the State Medical Society, presiding.

The following papers were presented on Tuesday: "Medicinal Foods," by E. Monroe Bailey, chemist; "Tumors of the Large Bowel," by Dr. Daniel F. Jones, and "Functional Gastro-Intestinal Disturbances," by Dr. Thomas R. Brown. In the afternoon group discussions of these papers were led by Dr. Brown, Dr. Eugen Kahn, Dr. Jones and Dr. Joseph I. Linde, after which the following demonstrations were given: Medicinal foods, Dr. Bailey; gastric pouch experiments, Dr. George R. Cowgill; vitamin deficiencies, Dr. Lafayette B. Mendel; pathological lesions, Dr. Samuel C. Harvey and staff, and Dr. Raymond G. Hussey and staff; gastro-intestinal studies, Dr. William A. LaField and staff; test meal, Dr. Albert J. Sullivan; dental pathology, Dr. Bert G. Anderson; hypodermoclysis, Dr. Grover F. Powers and staff; congenital anomalies of the digestive tract, Dr. Ethel C. Dunham; carcinoma of the stomach, Dr. Ashley W. Oughterson. The dinner meeting, addressed by Dr. Williams, began at seven o'clock.

Papers given on Wednesday morning include: "Fractures of the Lower Extremity," by Dr. Philip Wilson; "Fractures of the Upper Extremity," by Dr. Clay R. Murray; "The Control of Diphtheria by Bacteriological and Immunological Methods," by Dr.

Park; "Epidemiological Studies of Diphtheria Control," by Dr. Edward S. Godfrey; "Diphtheria in Connecticut," by Dr. Osborn; "Results in Bridgeport," by Dr. Wild; "Results in New Haven," by Dr. Rice.

In the afternoon a clinical pathological conference was led by Dr. Francis G. Blake and staff, and a round table discussion by Dr. C.-E. A. Winslow and staff. The dinner meeting at the New Haven Lawn Club was addressed by Dr. Theodore T. Zuck, of Cleveland, on "Maternal Health in Relation to Race Betterment."

Marital maladjustments were discussed on Thursday morning by Dr. William B. Terhune, of the Austen Riggs Foundation, and tuberculosis and pregnancy by Dr. David R. Lyman, director of the Gaylord Farm Sanatorium. An illustrated lecture on sterility studies was given by Dr. William H. Cary, of New York City. Dr. Robert L. Dickinson, secretary of the National Committee on Maternal Health, gave a talk on "Seven Years' Research in Contraceptive Methods." The congress concluded on Thursday afternoon with a group discussion of sexual adjustment in marriage, led by Dr. Josephine H. Kenyon, and a discussion of sterility, led by Dr. Cary.

THE BRITISH INDUSTRIAL HEALTH RESEARCH BOARD

THE eleventh annual report of the British Industrial Health Research Board has been published. According to a summary in the London *Times* it includes an analysis of the work published during the years 1926–30, and covers the whole field of industry.

It is claimed that real progress has been made in ascertaining the nature of some of the principal factors affecting human health and efficiency in industry. For example, the study of industrial fatigue in heavy work has now reached a stage which, in the opinion of the board, shows conclusively the fallacies of long hours and the benefits of suitable environmental conditions and of scientifically imposed rest pauses. The fatigue with which the board is now more concerned is the mental state produced by hours of monotonous work in an industrial world of progressively mechanized production, and in this connection close analysis of the various influences operating on those engaged in uniformly repetitive work has thrown fresh light on their reactions to it, as reflected by variations in output, speed and accuracy, and as expressed by symptoms of boredom shown by the workers themselves. Conclusions have been reached as to the way in which these conditions can be relieved by varying work and introducing rest pauses.

The report continues:

> In a more special sphere the practical value to workers engaged in fine work of using suitable spectacles was demonstrated—the particular new point here being the benefit to be derived from these spectacles by persons possessing normal vision. From the mental side, study of the incidence of nervous symptoms has served to remind those with managerial responsibility of the prevalence of workers who are temperamental misfits in their employment—and not all of them in subordinate positions.
>
> With the exception of the last, the instances mentioned are illustrative of advances in knowledge concerning the effects of the factors studied on workers regarded more as groups than as individuals. Reference, however, must be made to those studies dealing with the individual in relation to his occupation which are generally spoken of as vocational, and on which much of the work of the board bears. On the general aspect of these problems, research for the board is still confined to fundamental investigations of personal qualities in their relation to occupational training and success. The subject is vast and intricate, and though the board is convinced that as a result of these investigations improved methods of selection will eventually be devised, they are still at the stage of defining their terms. In one branch of this subject—the detection of the "accident prone" worker—information seems to have been obtained which should be capable of practical application at no distant date. Apart from this general question of testing for personal qualities, there are particular vocational questions which have been studied but about which also insufficient knowledge has as yet been gained to afford grounds for conclusions capable of practical application. Among these may be instanced the occupational fitness of mental defectives, and the preliminary study, already referred to, of those whose temperaments render them liable to nervous symptoms affecting their vocational fitness. It is in such types that are likely to be found the most noticeable reactions to various disturbing conditions of environment, such as noise, which are now being investigated.

SCIENTIFIC NOTES AND NEWS

DR. DAVID STARR JORDAN, chancellor emeritus of Stanford University and eminent ichthyologist, died on September 19 at the age of eighty years.

THE Grasselli Medal will be presented to Dr. L. V. Redman at a joint meeting of the Society of Chemical Industry with the New York section of the American Chemical Society, American Electrochemical Society and Société de Chimie Industrielle on November 6. The award has been made for his paper entitled "Cost of Research and its Apportionment," which was presented at a meeting of these societies on December 9, 1927.

DR. SHIRLEY W. WYNNE, health commissioner of New York City, was presented with a silver plaque by members of the staff of the department of health to commemorate his twenty-five years of service in the department.

PROFESSOR BRADLEY STOUGHTON, head of the department of metallurgy at Lehigh University, has been elected president of the Electrochemical Society for the year 1931–1932.

DR. WALTER T. DANNREUTHER, professor of gynecology in the New York Post-Graduate Medical School, was elected president of the American Association of Obstetricians, Gynecologists and Abdominal Surgeons, at their fifty-fourth annual meeting on September 15. He will succeed Dr. Arthur Holbrook Bill, of Cleveland. Other officers elected were: *First vice-president,* Dr. Herbert M. Little, of McGill University; *second vice-president,* Dr. Andre Crotti, of the Medical School of Ohio State University; *secretary,* Dr. Magnus A. Tate, of Cincinnati; *assistant secretary,* Dr. A. M. Mendenhall, of Indianapolis; *executive council,* Dr. Palmer Findlay, of Omaha, and Dr. Arthur H. Bill, of Cleveland. Dr. Ludwig Adler, of the University of Vienna, professor of gynecology in the Wilhelminenspital, Vienna, was elected an honorary fellow of the association, making the eleventh honorary fellow of foreign countries. As guest speaker, he gave an address on "The Treatment of Carcinoma."

H. MALCOLM READ, of York, was elected president of the Pennsylvania State Homeopathic Medical Society at the sixty-eighth annual meeting of the society, which was held in Pittsburgh on September 17. Dr. John D. Kistler, of Pittsburgh, was retiring president; William M. Hillegas, of Philadelphia, and E. H. Douds, of Beaver Falls, were chosen trustees. Officers elected are as follows: George G. Shoemaker, of Pittsburgh, *first vice-president;* William Doebele, of Huntingdon, *second vice-president;* C. F. Cutteroff, of Philadelphia, *secretary;* Anna Johnston, of Pittsburgh, *treasurer;* George A. Hopp, of Philadelphia, *necrologist,* and I. L. Moyer, of Columbia, *censor.*

DR. MAX C. STARKLOFF, city health commissioner in St. Louis, Missouri, for thirty years, was made president of the International Society of Medical Health Officers during the recent meeting at Montreal.

THOSE who will be new on the faculty at Yale University this year include: Dr. Edward Sapir, of the University of Chicago, Sterling professor of anthropology and linguistics and chairman of the department of social sciences; Dr. Walter R. Miles, of Stanford University, professor of experimental psychology; Howard Edward Boardman, of the Boston and Maine Railroad, Dudley professor of railroad engineering; Robert Ernest Doherty, of the General Electric Company, professor of electrical engineering.

ADDITIONS to the faculty of Columbia University include: Alan R. Anderson, associate director of the New York Post-Graduate Medical School; Boris A. Bakhmeteff, professor of civil engineering; Erwin Brand, associate professor of biological chemistry, school of medicine; Clarence Orion Chene, professor of clinical psychiatry, school of medicine; William Morris Davis, visiting professor of physiography during the winter session; Frederick L. Fitzpatrick, associate professor of natural sciences in Teachers College; Edward Hicks Hume, director of the New York Post-Graduate Medical School; Alfred L. Kroeber, visiting professor of anthropology during the spring session; Henry Lea Mason, assistant professor of mechanical engineering; Jan Schilt, associate professor of astronomy, and Ramon J. Sifre, associate professor of hygiene and public health in the school of tropical medicine.

THE following appointments have been made at the University of Maryland: Dr. R. C. Yates, assistant professor of mathematics; Dr. Glenn A. Greathouse, assistant professor in plant physiology; Norman E. Phillips, assistant professor in zoology, and Dr. Ronald Bamford, assistant professor in botany.

DEXTER S. KIMBALL, JR., has been appointed assistant professor of industrial engineering at Cornell University. Promotions from instructor to assistant professor include: R. P. Agnew, mathematics, A. B. Burrell, plant pathology, G. A. Knaysi, Jr., bacteriology, and M. G. Northrop, electrical engineering.

DR. A. JOHN SCHWARZ has been promoted to the rank of associate professor of botany and pharmacognosy, in the division of pharmacology of the Memphis branch of the University of Tennessee.

DR. ROBERT BURRI, director of the Swiss Federal Dairy Research Institute, Berne, Liebefeld, Switzerland, and Dr. Otto Baumecker, of the Federation of Westphalian Landowners Organizations, Hamm, Westphalia, recently visited the U. S. Bureau of Dairy Industry in Washington as part of their investigations of dairy conditions in this country. Dr. Burri officially represented the League of Nations for the study of dairy sanitation and milk control. Dr. Baumecker was especially interested in dairy sanitation and cooperative marketing of dairy products.

DR. CHRISTIAN RICHARD THURNWALD, of the University of Berlin, Bishop Museum visiting professor of anthropology, will give instruction and direct research at Yale University in the problems of the

Pacific area under the terms of the agreement by which Yale and the Bishop Museum of Honolulu are affiliated.

DR. ERVIN R. VAN DER JAGT and Harry L. Kutz will succeed Jacob C. Sparrow and Harry J. Clausen in the department of biology at Norwich University.

DR. LEWIS J. MOORMAN, professor of clinical medicine at the University of Oklahoma School of Medicine, has been made dean in succession to Dr. Leroy U. Long.

DR. ALLEN F. VOSHELL has been appointed professor of orthopedic surgery at the University of Maryland, and has also become surgeon-in-chief at the James Lawrence Kernan Hospital for Crippled Children. Dr. Charles Bagley, Jr., has been appointed professor of neuro-surgery at the University of Maryland.

DR. LEON J. MENVILLE, of New Orleans, has been made editor of *Radiology*, the journal of the Radiological Society of North America. He has succeeded Dr. Maximilian J. Hubeny, of Chicago.

MR. J. E. FLANDERS has been appointed chief engineer of the Missouri Public Service Commission to succeed Mr. F. M. Plake.

DR. KOTARO HONDA has been elected president of the Tohoku Imperial University at Sendai, Japan. Dr. Honda was professor of physics at Tohoku Imperial University and director of the research institute for iron, steel and other metals at the university.

The following changes have been made at the University of Cambridge: Dr. A. Harker has resigned his readership in petrology in St. John's College; Dr. F. R. Winton has been appointed university lecturer in physiology in Clare College, and Dr. E. G. Holmes has been appointed university lecturer in pharmacology in Christ's College.

DR. CHARLES SINGER, lecturer in the history of science at University College, London, who made an extensive lecture trip in the United States in 1929, expects to spend the winter of 1931–32 at the University of California at Berkeley. Between April 20 and May 20, 1932, Dr. and Mrs. Singer expect to lecture at a number of American colleges and universities. Inquiries as to their schedule may be made of Dr. George W. Corner, School of Medicine and Dentistry, University of Rochester, Rochester, New York.

PROFESSOR HERBERT GRAHAM CANNON, professor of zoology at Sheffield University since 1926, has retired.

SIR WILLIAM DAMPIER has been appointed secretary of the Agricultural Research Council, England, and Mr. E. H. E. Havelock has been appointed assistant secretary.

THE sixth annual William deMille Campbell memorial lecture of the American Society of Steel Treating was presented in Boston on the morning of September 23 in the ballroom of the Hotel Statler by Dr. C. H. Herty, Jr., supervising chemist in charge of the metallurgical section of the U. S. Bureau of Mines Experiment Station in Pittsburgh. The first Campbell lecture was delivered in 1926 by Wilhelm M. Guertler, associated with the Metall-Institut der Technischen Hochschule in Berlin. Succeeding lectures and their topics have been: 1927—"Contribution to the Theory of Hardening and the Constitution of Steel," by Dr. Zay Jeffries, consultant, Aluminum Company of America and General Electric Company; 1928—"Application of Science to the Steel Industry," by Dr. W. H. Hatfield, Brown-Firth Research Laboratories, Sheffield, England; 1929—"Steel at Elevated Temperatures," by Dr. Albert Sauveur, Gordon McKay professor of metallurgy and metallography, Harvard University; 1930—"Oxygen in Steel," by Dr. M. A. Grossmann, director and vice-president, Republic Research Corporation, at Canton, Ohio.

THE fourth annual meeting and conference of the committee on electrical insulation, of the division of engineering and industrial research of the National Research Council, will be held at Harvard University on November 13 and 14. There will be three technical sessions with papers on the physics and chemistry of dielectrics and on recent progress in engineering research in the field of dielectrics, as applied to the insulation of electric circuits. A dinner on the evening of November 13 will be followed by a lecture dealing with recent advances in dielectric theory. Dr. J. B. Whitehead, of Johns Hopkins University, is chairman of the committee.

THE second International Congress on the Rat and Plague will be held in Paris from October 7 to 12. Professor Gabriel Petit is secretary of the congress.

THE *British Medical Journal* reports that the second International Congress of Comparative Pathology will be held in Paris at the Faculty of Medicine from October 14 to 18. Professor Charles Achard will preside. The subjects for discussion include B.C.G. immunization; Brucella infections in man and animals; mineral salt deficiencies in man and animals; the distribution of the ultra-virus agencies, and the diseases attributable to them, and helminthic infections. The congress is open to medical and veterinary practitioners and those interested in the diseases of plants. Further information may be obtained from the general secretary, 7 Rue Gustave Nadaud, Paris, France.

WE learn from the *Journal* of the American Medical Association of the thirty-sixth annual meeting of the American Academy of Ophthalmology and Oto-

laryngology, which was held at French Lick, Indiana, from September 13 to 19, with headquarters at the French Lick Springs Hotel. The scientific program included papers by Dr. Edward Jackson, of Denver, on "Share of Crystalline Lens in Ocular Refraction"; Dr. Cecil S. O'Brien, of Iowa City, on "Astigmatism —Its Accurate Determination and Correction"; Dr. Leo L. Mayer, of Chicago, "An Experimental Study of Detachment of the Retina and Its Surgical Therapy"; Dr. Lyman G. Richards, of Boston, on "Prognostic Significance of Sinusitis in Children"; Dr. Ernest Fulton Risdon, of Toronto, on "Management of the Fractured Nose"; Dr. Albert N. B. Lemoine, of Kansas City, Missouri, on "Progress in Diagnosis and Pathology in Ophthalmology"; Dr. William A. Wagner, of New Orleans, on "Diagnosis and Conservative Treatment of Sphenoid Suppuration," and Dr. John J. Shea, of Memphis, on "Nasal Obstruction and Systemic Consequences." A symposium on aviation medicine was conducted on the evening of September 15, by Dr. Louis H. Bauer, of Hempstead, N. Y.; Dr. Conrad H. Berens, of New York; Dr. Harry T. Smith, of Humeston, Iowa; Dr. Ralph A. Fenton, of Portland, Oregon, and the Honorable David S. Ingalls, assistant secretary of the U. S. Navy in charge of aviation, and a dinner was given in honor of Dr. Luther C. Peter, of Philadelphia, who is retiring from the council after thirteen years of active service as acting secretary, secretary and president.

The annual general meeting of the British Dental Association, which was held at Cardiff, opened on August 26. In addition to the two hundred delegates from Great Britain, several Canadian members of the profession who attended the eighth International Dental Congress at Paris were in attendance. At the opening meeting, the Lord Mayor and the authorities of the University College of South Wales and Monmouthshire, where the conference is being held, extended a welcome to the delegates, and Mr. William Kittow, of Cardiff, was installed as president in succession to Sir Norman Bennett.

DR. C. C. LAURITSEN, of the California Institute of Technology, will shortly start in operation the world's largest and most powerful x-ray tube. The tube is approximately thirty feet long and uses 2,000,000 volts of electricity. All the work of constructing the tube was done in the shops of the institute under the direction of Dr. Lauritsen, assisted by students. Glass cylinders, twenty inches high and tapering from eighteen inches to twelve inches in diameter, form the glass exterior of the long tube. Inside are two electrodes.

DARTMOUTH COLLEGE has received $70,000 by the will of the late Dr. R. Melville Cramer.

UNDER the will of David A. Kistler, Carthage College will receive a legacy of $15,000, after the death of Mrs. Kistler.

DURING July and August Dr. Alexander Forbes, of Harvard University, carried out an expedition to Labrador in cooperation with Sir Wilfred Grenfell. The society was named the Grenfell Northern Labrador Expedition. The expedition was sponsored by the American Geographic Society, and Mr. O. M. Miller, of the society's school of surveying, was associated with Dr. Forbes as topographer in charge of surveys. The scientific personnel of the expedition also included Mr. Noel E. Odell, in charge of the geological work, and Mr. Ernst C. Abbe, botanist, representing the Gray Herbarium.

THE Mont Blanc Astronomical Observatory, built thirty years ago by Professor Vallot, has become the property of the Paris Observatory. It stands at an elevation of 14,435 feet, and will enable astronomers in Paris to undertake researches for which they have not hitherto been equipped.

THE experiments and the seed and bulb business of the late Luther Burbank will be continued by the W. Atlee Burpee Company, seed dealers of Philadelphia, it has been announced by David Burpee, president of the company. Through an agreement with Mrs. Burbank, the company has leased the Burbank property at Santa Rosa, California, and has received the famous collection of what Mr. Burbank considered his most valuable seeds for preservation from season to season. While the experiments will be continued on the ground used by Mr. Burbank and with the plants he cultivated there, Mrs. Burbank will continue to live on the property. The late W. Atlee Burpee, father of David Burpee and W. Atlee Burpee, Jr., secretary and treasurer of the firm, were cousins of Mr. Burbank. They were closely associated in experimental work. The work at Santa Rosa will be conducted by the Burpee Company in connection with its experiments at Floradale Farm, Santa Barbara County, California, and at Doylestown, Pennsylvania.

THE Associated Press reports the discovery of six steep-walled, narrow canyons, announced by Dr. Frederick J. Pack, head of the department of geology of the University of Utah. It is believed that Dr. Pack's party was the first ever to descend into them. The newly explored canyons are said to rival the famous Zion Canyon for gorgeous colorings and unusual formations. There are sheer bare-faced cliffs of 2,300 to 3,000 feet in height, varying in length and spreading along a distance of three to five miles. In places some are so narrow that a person with outstretched arms can touch either side.

DR. A. C. MCFARLAN, professor and head of the department of geology at the University of Kentucky, has spent the greater part of the summer studying the ordovicious stratigraphy of several counties in the Blue Grass, and identifying the different formations outcropping in various communities, in an attempt to correlate them with known formations elsewhere. Clark, Anderson, Scott, Campbell, Pendleton and Grant Counties have been visited and the study of these counties will be compared with compiled information on the stratigraphy of southern Ohio, Indiana and central Tennessee, in an attempt to work out the early geographic history of the area and the nature of existent life at that time.

THE small auxiliary schooner, *Aleda,* owned by John Lippincott, of the Corinthian Yacht Club, Philadelphia, has sailed with fifteen Princeton students from Halifax for the west coast of Newfoundland, where an extensive study will be made of iron ore and chrome deposits, and the shore line itself. The *Aleda,* which is manned by the students, is commanded by Mr. Lippincott. The expedition is under the direction of Dr. A. K. Snelgrove, instructor in the department of geology, and John Streeter, psychologist, of Princeton University. After a month in the north, the party will return to New York.

ADDITIONS to the collections of the British Museum (Natural History), South Kensington, include the skin and skull of a young Menelek's bushbuck, shot at Monnegesha in Abyssinia, presented by the Duke of Gloucester. Ninety-five heads and skulls of Asiatic and American ungulates and carnivora have been selected from the collection of the late Mr. C. St. George Littledale. In addition to three record heads, the collection contains a number of exceptionally fine specimens, including the skull of a wild camel from Lob Nor in the Gobi Desert and a collection of over 60 skulls of ungulates and lions from Northern Rhodesia. The collections brought back by Mr. Bertram Thomas from the Ruba el-Khali are now being worked out, and a selection is on exhibition in the Central Hall. The 82 specimens of reptiles and amphibians represent about 25 species, some of which appear new to science. The collections include 500 entomological specimens. All the larger orders of insects are represented in about 120 species, of which some 20 appear to be new to science. A large collection of mammals has been received from the Game Department of Uganda, collected for the most part by Mr. J. Jardine. The museum has also obtained a further abnormal tusk of a Uganda elephant from Mr. W. A. Bowring, of Gibraltar. An unusual type of stony meteorite which fell at Karoonda, South Australia, on November 25 last has been given to the Mineral Department by Professor Kerr Grant, of the University of Adelaide.

DISCUSSION

EXPULSION OF GAS AND LIQUIDS FROM TREE TRUNKS

ABELL and Hursh's recent paper on gas and water pressure in oaks[1] recalls some observations made on three days in July, 1916, but hitherto unpublished. At that time I was engaged in making a study of the growth of standing trees at elevations of about 1,500–2,000 feet in Letcher County, Kentucky, the increment borer being used in this work. Inasmuch as these few observations include species of other genera than oak, they are here offered as a further contribution to the subject.

In one instance, as the increment-borer bit was withdrawn from a tree of black gum (*Nyssa sylvatica*), a pronounced blast of gas expelled some of the wood dust perhaps three inches from the 0.6-inch bark. This tree was 14 inches in diameter at breast height, 16 at the level of boring, and about 135 years old at this level. The bit had penetrated 4 inches through solid wood to a somewhat decayed heart.

While a boring was being made in a red oak (*Quercus rubra;* 13 inches in diameter at breast height, 15 at the level of boring) an outward blast started which increased suddenly and explosively when the increment-borer bit was withdrawn. The tree was 42 years old at this height; and apparently sound for the outer 3 inches of core.

In the case of a chestnut tree (*Castanea dentata*), 15 inches in diameter at breast height, 18 at the level of boring, a stream of discolored liquid was expelled a maximum distance of 30 inches, the flow lasting 20 seconds. When a boring was made 1 inch above the first hole, liquid flowed out of the lower hole for 90 seconds. The tree was 34 years old at the height of the upper hole and the wood was sound for 4 inches of radius. There had been rain the preceding night.

In the case of a hickory tree (*Hicoria glabra* ?; 21 inches at breast height, 25 at the level of boring), liquid began running out during the boring and be-

[1] C. A. Abell and C. R. Hursh, "Positive Gas and Water Pressure in Oaks," SCIENCE, 73: 499, 1931.

came a considerable stream when the bit was withdrawn. Gas expulsion, indicated by bubblings, continued for 5 minutes or more. The age at the boring level was 58 years. The outer 4 inches of core was apparently sound.

The gas pressure in a hollow hickory tree blew a 2-inch section of wood out of the end of the increment-borer bit. This tree was 11 inches in diameter at breast height, 14 at the boring level.

It is to be noted that these trees, like those mentioned by Abell and Hursh, were all dicotyledonous Angiosperms, and all defective. Except for the last-mentioned all the manifestations above recorded were observed in the morning. The trees in which such phenomena occurred constituted a relatively small proportion of those bored, but no precise figures on this phase of the study are now available.

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CATFISH FEEDING ON THE EGGS OF THE HORSESHOE CRAB, LIMULUS POLYPHEMUS

THE horseshoe or king crab, *Limulus polyphemus*, is very common along the gulf coast of southern Florida. It lives in mud or sand just below low tide level, and never leaves this except in early spring when in great numbers it comes inshore to spawn in the sand near high water mark. The female in the lead, followed by one or more males, excavates a shallow hole in the sand in which the eggs are deposited and covered with milt. The eggs are about 2 mm in diameter, are pale Nile-green in color, are laid singly and are not protected by any gelatinous mass or capsule. They hatch within three to six weeks, after which time the young may be seen making their way to deeper water.

Early in April, 1930, while collecting mollusks on a sandy flat near the mouth of the Caloosahatchee River, my attention was attracted by a great commotion involving a considerable area of shallow water. Here were hundreds of spawning *Limulus* attacked by other hundreds of catfish which were voraciously and joyously devouring the eggs as fast as deposited. Each spawning female king crab and her attending males were surrounded by many catfish in groups which may perhaps best be described as "bouquets" or "rosettes." These catfish stood almost vertically on their heads, with their tails out of water, whipping the surface of this into a maelstrom in their ecstasy of feeding. Crabs and catfish were pushed and shouldered about by other fish circling about the groups in a determined effort to reach the feast. Literally hundreds of both horseshoe crabs and fish were concerned in this phenomenon which was watched until the rising tide made further observation impossible.

But one other observation (and it an incomplete one) of this kind seems to be on record, and it as far back as 1897. In the *American Naturalist* for this year (vol. 31, p. 347–348) H. C. Warwell records his observations on "Eels Feeding on the Eggs of *Limulus*." He states that in 1892 or 1893, in the latter part of May he was walking about dusk along the Kickemuit River between Warren and Bristol, Rhode Island, when he noticed many king crabs or "horse-feet" as he calls them, crawling on the sandy bed of the river. Here are his own words:

> The tide was high, and they [the "horse-feet"] had come in from the outside, as is their habit at high water. What attracted my attention the most was the fact that, as they lay there on the river bottom, many eels had worked their way into the clefts between their heads and abdominal regions, and were apparently feeding. Some of the eels were very large, and made a strange sight with their heads under the shell [of a crab] and their tails sticking out sideways. Sometimes two or three were under one horse-foot, and if I had had an eel spear I could have caught a good mess. I have since wondered what the eels were eating. Sometimes I think it might have been something on which the horse-feet were feeding; but my uncle, who was with me, said that they were after the spawn; and I have since come to the conclusion that he was right, for it was the spawning season, and the eels were only gathered around the large female horse-feet.

In the light of my observation it would seem to be clear that the eels were feeding on the eggs of the horseshoe crabs, and that at the breeding season the eggs of these crabs are preyed on extensively by predatory fishes

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THE LACK OF CORRELATION BETWEEN ANEMIA AND THE PELLAGRA-LIKE SYMPTOMS IN RATS[1]

IN a recent article Bliss[2] has presented evidence claiming to show that pellagra as it exists in humans, and black-tongue of dogs—which is considered to be analogous to human pellagra—are both due to iron deficiency. He points out that pellagra is more prevalent among women than among men, resulting possibly from the loss of iron by women in menstruation. He calls attention to the fact that the foods rich in vitamin G and in the black-tongue preventive factor are almost without fail rich in iron—liver, egg yolk, beef and yeast. Further, he states that in Goldberger's work "those diets which prevented or cured black-tongue in dogs are just those to which had

[1] Published by permission of the director, Journal Article No. 61 (n. s.).
[2] Sidney Bliss, SCIENCE, 72: 577, 1930.

been added syrup iodid of iron USP." This was added to improve the mineral composition of the diet. The author states that the results of iron therapy have been studied by him on fifty-one cases of human pellagra and they are of an encouraging nature. Moreover, he has been able to cure black-tongue in dogs by giving iron intravenously.

The correlation between the iron and the vitamin G content of certain foods is striking. In addition to the above-mentioned foods it is known that spinach, leaves of velvet beans and soy beans, pig's liver and even the Minot and Murphy liver extract are good sources of the vitamin. However milk which is a rich source of vitamin G is relatively low in iron, and molasses, which forms a staple article of diet among poor farmers in the South, is rich in iron.

Whether or not the vitamin which prevents the pellagra-like condition and promotes growth in rats is identical with a factor preventing human pellagra has not been determined. Aykroyd[3] recently has shown that maize contains about as much vitamin B_2 (G) as rice and millet, as measured by the rat-growth method, but people who live largely on rice are not pellagrous, while the disease is prevalent among maize-eating peoples.

In this laboratory we have been conducting experiments to determine the vitamin G (B_2) content of some foods and of various preparations. Rats were used, and the basal diet contained ferric citrate in such amounts that there was present 0.29 mg of iron in each gram of diet. In every litter of animals used for experimental work one rat was maintained on the basal diet alone as a negative control, and the food consumed by these animals even when sick was rarely less than 1.5–2 grams daily. Out of thirty-three of these negative controls only three have failed to show evidence of dermatitis in eight weeks. In most cases the condition was evident in three or four weeks. None of the animals gained more than ten grams in eight weeks, and the majority lost from five to ten grams. From this evidence it would seem that the animals were deficient in vitamin G (B_2). Throughout the experimental period, moreover, the animals were housed in metal cages and in many cases the iron was exposed. In addition, the loose screen bottom of the cage was raised above the pan by means of an iron ring. While no copper was given as such it seems possible that from the cages and from the salts used in the diet sufficient copper may have been present to satisfy the needs of the animals.

In order to satisfy ourselves on this point, however, six animals were given 0.5 mg of iron and 0.1 mg of copper daily six days a week as $FeCl_3$ and $CuSO_4$ solutions, respectively, as recommended by Steenbock.[4] Three of the animals had been maintained for ten weeks on the experimental diet alone, and they were in a very poor condition. The other three were young rats which had just been depleted of their store of the vitamin. The solutions were given as the only supplement to the basal diet and they were well eaten; and when given in addition to the iron and presumably copper present in the diet would seem to have been sufficient to prevent anemia. In neither group, however, was there any improvement due to iron therapy. The rats which had severe dermatitis did not improve and the second group began to show evidence of vitamin G (B_2) deficiency in about four weeks. In no case was there a gain in weight such as was seen in the experiments reported by Steenbock and which might have been expected had the animals been anemic.

It seems probable therefore that if human pellagra and black-tongue of dogs are shown to be iron deficiency diseases, the pellagra-like symptoms which manifest themselves as a result of vitamin G (B_2) deficiency in rats are not analogous to the other conditions.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A LIGHT FILTER FOR MICROSCOPES

IN microscopes there are two points where light filters can be introduced without being imaged and yet produce equal filtering power throughout the field. These positions are known as the entrance pupil and the exit pupil. The entrance pupil is the aperture of the substage condenser where the iris diaphragm is located. The exit pupil is better known as the Ramsden disc and is in the position the eye occupies when looking through the microscope. Either position is correct for a filter, but because of certain disadvantages in placing the filter at the exit pupil, all standard filters are made to occupy the entrance pupil. The disadvantages in locating the filter at the exit pupil are that it cuts down the eye distance; the filtering density must be greater to cause the same value of light filtration; and any dirt, scratches, etc., on the filter are more easily seen and may be quite annoying. A filter located at the entrance pupil has none of these disadvantages but is in an exceedingly

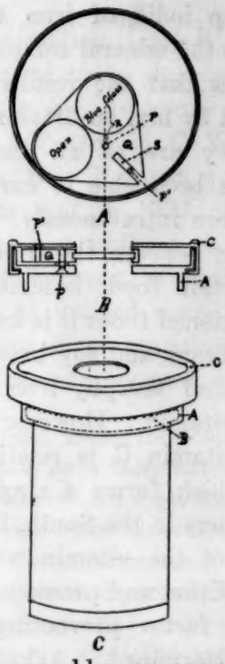
[3] W. R. Aykroyd, *Biochem. Jour.*, 24, No. 5, 1479, 1930.

[4] E. B. Hart, H. Steenbock, J. Waddell, and C. A. Elvehjem, *Jour. Biol. Chem.*, 77: 797, 1930.

annoying place to get at when throwing the filter on or off frequently, especially if substage lights are used. Breakage and loss is also frequent with filters in this position.

In finer cytological work, where the advantages of contrast of normal illumination with that of the shorter wave filters is appreciable, the rapid shifting of substage filters is very inconvenient. The writer has therefore been using a fixture which introduces the filter at the exit pupil where it can be rapidly and conveniently thrown on or off. This filter is so closely apposed to the eyepiece that the cutting down of eye distance is not appreciable. The fixture also adequately protects the filter from dust, scratches and breakage. It consists of a fixed cap that fits over the eyepiece. To the upper surface of this piece a movable quadrant is attached in which the filter aperture and an open aperture is contained. Either of these apertures can be shifted in place over the lens by simply swinging the quadrant to the right or left on its axis. This is accomplished by means of a movable cap that fits over the fixed part and from which a pin fits into a slot on the quadrant. Any movement of the cap to the right or left will therefore throw the quadrant and its apertures in the opposite direction.

From the diagram it will be seen that this device consists of a machined support block (A) which carries a lip that engages the knurled rim (B) of the eyepiece with a firm push fit. The quadrant (Q) which carries the filter glass rotates freely about the bearing pin (P), which is fixed to the support block. Another machined piece (C) (the movable block) fits concentrically over the fixed block in such a way that (C) can be rotated freely about it with the fingers. The quadrant is slotted at (S) to engage a second pin (P′) fixed to the movable block.



A. Top view with movable cap removed. B. Sectional view. C. Eyepiece with fixture in position.

In the position shown in the plan view the glass filter has been swung into position by simply turning the movable piece (C) to the right. The limit of this motion is reached when the left hand edge of the quadrant abuts against the lip of the fixed block (A), as shown. The radius (R) is such as to swing the filter into correct axial relationship with the eyepiece.

When the filter is not needed the movable piece is turned to the left This carries the quadrant to the right rotating about the fixed pin (P) and impelled by the movable pin (P′). The other edge of the quadrant now abuts against the rim of the block, swinging the "open" part of the quadrant into its correct position.

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SPECIAL ARTICLES

CONTROL OF POWDERY MILDEW AND RED SPIDER ON GREENHOUSE CUCUMBERS[1]

DUSTING greenhouse cucumbers with a high grade sulphur dust is the common method of combating powdery mildew, *Erysiphe cichoracearum*. Such dusts, while generally effective, occasionally fail. In an attempt to find a more efficient method of controlling the disease, cucumber vines in a commercial greenhouse were sprayed with hydrophilic colloidal sulphur, a product recently manufactured by the Ansul Chemical Company. This product is prepared in paste form and is a true hydrophilic colloid.

[1] Published with the approval of the director of the Ohio Agricultural Experiment Station.

Preliminary sprays were applied before mildew made its appearance. These were made to determine the strength of sulphur spray which greenhouse cucumber vines would tolerate and what effect hydrophilic colloidal sulphur would have on the control of red spider, *Tetranychus telarius*.

The following sprays were applied March 23, 1931: 5 pounds of the colloidal sulphur to 100 gallons of water and 10 to 100 with and without 0.5 per cent. Penetrol.

An examination of the vines several days later showed that all sprays gave a perfect kill of spider. The 5 to 100 sulphur sprays caused slight leaf injury and the 10 to 100, rather severe leaf injury. Both

sprays with Penetrol as a spreader caused severe leaf injury.

Following this first attempt it seemed advisable to try a series of sprays with less colloidal sulphur. Four strengths were used: 0.5, 1.0, 2.0, and 4.0 pounds. Four applications of these sprays were made on the following dates: April 11, 20, 27 and May 4. These sprays had no harmful effect on the plants. The 4–100 and 2–100 gave excellent commercial control of spider. Less satisfactory results were obtained with the 1–100 and the 0.5–100 gave very little control. By this time mildew had made its appearance and the plants sprayed with a 1–100 spray or stronger were free of the disease.

On May 4 the manager of the greenhouse became interested and wanted to try some of the colloidal sulphur spray. Accordingly, a complete house, the one with the most severe infestation of red spider, was sprayed using 1.5 pounds of the colloidal sulphur to 100 gallons of water. This spray was very effective and in a week was followed by another using 1.75 pounds of sulphur to 100 gallons of water. No injury resulted and four more sprays were applied at weekly intervals using a 2–100 spray.

After the second and third sprays spiders were scarce and mildew was almost absent. In the adjoining houses spiders were serious and mildew quite prevalent. This one season's experience indicates that red spider and powdery mildew on greenhouse cucumbers can be successfully controlled with hydrophilic colloidal sulphur spray. The strength of spray suggested for greenhouse cucumbers is 2 pounds of the sulphur paste to 100 gallons of water. This gave excellent control and has a wide margin of safety.

This is not the first use of hydrophilic colloidal sulphur spray as an acaricide. DeOng,[2] 1924, found it to be very effective against the red spider *Bryobia pratiosa*. He prepared his sulphur in the laboratory according to Young.[3] His results showed excellent control but he concludes hydrophilic colloidal sulphur would not replace lime sulphur, at least until a cheap method of manufacturing it was devised. The strength of sulphur suggested will cost about the same as lime sulphur and considerably less than nicotine sulphate.

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[2] E. R. DeOng, "The preparation and use of colloidal sulphur as a control for red spider," *Jour. Econ. Ent.* 17: 533–538, 1924.

[3] H. C. Young, "The toxic property of sulphur," *Ann. Mo. Bot. Gard.* 9: 403–435, 1922.

PHAGOCYTOSIS OF BRUCELLA, AN INDEX OF IMMUNITY TO UNDULANT FEVER IN MAN

STUDIES of the phagocytic activity of the polymorphonuclear cells in the blood of man toward the genus *Brucella* have revealed an important relation between this phenomenon and susceptibility and immunity toward undulant fever.

It has been found that the cells of individuals who have never knowingly been in contact with *Brucella* infective materials or who have not had undulant fever, possess little if any phagocytic activity for the organism when mixed with it *in vitro*. The polymorphonuclear cells of those who have handled infective materials, such as cultures or infective tissues, and of those who have recovered from undulant fever have marked phagocytic activity. It has been found from the study of many such cases that from 80 to 100 per cent. of these particular cells will ingest *Brucella* to a marked degree.

During the course of the infection in man the phagocytic activity of the cells will vary. As a rule only slight, if any, phagocytosis will be seen. As recovery takes place, the phagocytic activity of the cells increases rapidly.

There appears to be no relationship between the agglutination titer of the serum and the phagocytic activity of the cells in the same individual. Phagocytosis may be negative when the serum shows a titer of 1 to 2,000, or 100 per cent. of the cells may show a marked phagocytosis when serum agglutinins cannot be demonstrated in a dilution of 1 to 25 or higher.

The phagocytic activity of the polymorphonuclear cells in individuals who have recovered from undulant fever appears to persist for a considerable period of time. These cells of one individual three years after recovery and several one year after recovery show a phagocytosis of 100 per cent.

The technic which we are using in this study is as follows: Blood is collected and mixed with sterile, two per cent. sodium citrate physiological salt solution. The blood cell suspension is added to a suspension of a strain of *Brucella* (turbidity 3 McFarland nephelometer) in the proportion of 1 to 1 and mixed well. The mixture is then placed in a 37° C. incubator for 30 minutes. At the end of this period, the cells are smeared on slides and stained with Hastings blood stain. On microscopic examination, 50 to 100 polymorphonuclear cells are examined. The cells are grouped according to whether they show a marked, moderate, slight or no ingestion of the bacteria.

A more detailed report of this study will appear in the *Journal of Infectious Diseases*.

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THE EFFECT OF TEMPERATURE ON THE NUMBER OF SCALES IN TROUT

IT has long been known that fish from southern localities usually have a smaller number of scales than those of the same species from farther north, and it has been assumed that the decrease in the number of scales is due to the higher temperature under which the individuals develop. While some writers postulate a theory of selection of those individuals which are best constituted to meet the temperature conditions of the environment, others have proposed a direct effect on the integumentary system. As far as the writer is aware, no one has previously demonstrated from the experimental side that the number of scales can be directly modified by temperature. During the past summer an experiment was conducted on the eggs and alevins of Kamloops trout (Salmo kamloops) to determine the effect of temperature in this respect. The index chosen to specify the number of scales was a count of the number of oblique, parallel rows running in a downward and backward direction from the dorsum to the lateral line. The series begins just behind the head and ends at the termination of the vertebral column. Kamloops trout of Kootenay Lake were selected for the experiment. These trout have an average index of 145 rows with a standard deviation of about 6 rows; the total range is 130–160 rows. Eggs were obtained for the experiment on May 23 from fish at the end of the spawning run. Six pairs of trout were selected and the eggs of each pair were kept separate. The alevins and fry produced from these were reared in the hatchery at Nelson, B. C., under the ordinary hatchery temperatures. The water temperature in the hatchery begins to rise from the stationary winter level (1°–2° C.) at the end of February. It rises continuously until the end of July or the first week in August when it is 12°–13° C. The eggs from the end of the spawning run thus develop under warmer temperatures than the eggs from the earlier part of the run. The average index for each of the six lots of fry was in every case below the lower limit of the standard deviation for the normal population (below 139 rows). In each case the index of the offspring was significantly below the counts for their own parents. This part of the experiment indicated that the individuals having a low scale count in the normal population are probably produced from eggs which have been deposited at the end of the spawning run and have, consequently, developed at a higher temperature. In order to check this theory a random sample of eggs spawned during the middle of the run was removed from the hatchery on June 24 at the eyed-egg stage. These were reared at a temperature approximately 5 Centigrade degrees above that occurring in the hatchery until August 10, when the warmer temperature was discontinued. In these fry the average number of scale rows was reduced by 10 from the normal average for the population. A corroborative experiment was carried out with the eggs from one of the six pairs mentioned above. The eggs were divided into two lots:

Lot 1 was reared at ordinary temperatures. The resulting fry had a scale count of 132 rows on the average and were 13 rows below the normal population—16 rows below the female parent and 17 rows below the male.

Lot 2 was reared at the higher temperature, namely, 5 Centigrade degrees above normal. The resulting fry had an average scale count of 127 rows or 18 below the normal average and 21 and 22 rows below the female and male parent respectively.

From these experiments it seems evident that in Kamloops trout the number of scales is directly modified in an inverse manner by temperature, the higher the temperature, the fewer the scales. The data will be more fully presented and discussed in a forthcoming paper.

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BOOKS RECEIVED

BRITISH MUSEUM OF NATURAL HISTORY. *Diptera of Patagonia and South Chile.* Part II; Fascicle 4: *Simuliidae*, by F. W. Edwards. *Ceratopogonidae*, by A. Ingram and J. W. S. Macfie. Pp. 121–232. 34 figures. The Museum. 5 shillings.

BROWN, LAWRASON and FRED H. HEISE. *The Lungs and the Early Stages of Tuberculosis.* Pp. 151. Appleton. $1.50.

DEPARTMENT OF AGRICULTURE, UNIVERSITY OF CAMBRIDGE. *Farm Economics Branch Report Number 18. An Economic Survey of Hertfordshire Agriculture.* Pp. v + 104. Heffer, Cambridge. 2/6.

DODGE, RAYMOND and EUGEN KAHN. *The Craving for Superiority.* Pp. vii + 69. Yale University Press. $1.50.

ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH. *History; Organization; Present Scope of the Scientific Work; Buildings and Equipment; Publications.* Pp. 36. Illustrated. The Institute.

SHAPLEY, HARLOW. *Sidereal Explorations.* Pp. 45–115. 25 figures. Rice Institute.

SHEWHART, W. A. *Economic Control of Quality of Manufactured Product.* Pp. xiv + 501. 147 figures. Van Nostrand. $6.50.

STROMSTEN, FRANK A., editor. *Mammalian Anatomy with Special Reference to the Cat*, by Alvin Davison. Fifth edition, revised. Pp. xiv + 311. 141 figures. Blakiston. $2.50.

WALTERS, NELSON F. *Inheritance of Body-Weight in Domestic Fowl.* Pp. 105. 46 figures. Agricultural Experiment Station, Rhode Island State College.